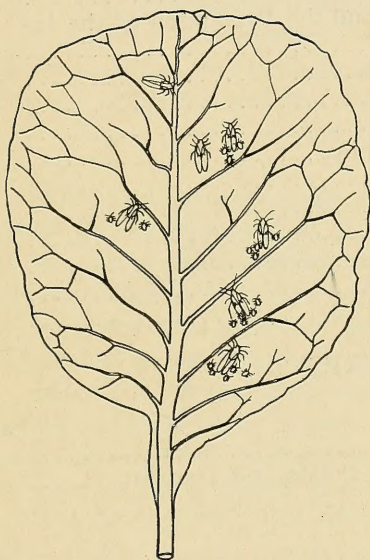


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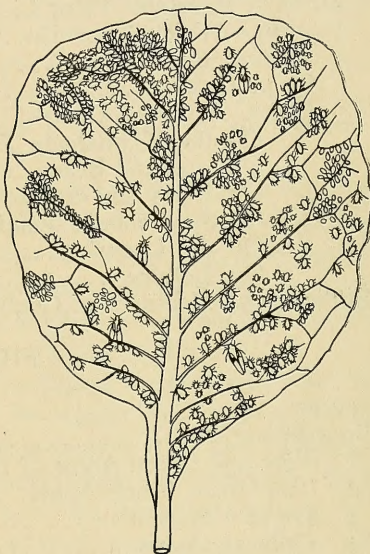
NEW JERSEY

AGRICULTURAL EXPERIMENT STATIONS

CIRCULAR 107



RIGHT TIME TO KILL PLANT LICE



TIME FOR KILLING LICE GONE BY;
THREE-FOURTHS OF THE DAMAGE DONE

VEGETABLE PLANT LICE

EXHIBITION

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NEW JERSEY AGRICULTURAL EXPERIMENT STATIONS

CIRCULAR / 107

VEGETABLE PLANT LICE*

Introduction

Information on the plant lice affecting vegetable crops is not only limited but is scattered through various publications devoted to other subjects. The experience of the past several years and especially last year has shown the great need for a publication which shall bring our available knowledge together in a compact form, adapt it to New Jersey conditions, and render it available to our vegetable growers.

With very few exceptions, among our growers there exists at present no clear appreciation of the fact that different species with different habits are concerned, no clear idea as to just what insecticides should be used and just what strengths of the same are necessary, no clear idea as to just what machinery is available, and no clear idea as to just how the applications should be made.

While information on all these points is altogether too limited, there is a considerable amount of knowledge, which properly arranged and digested, should give the grower a great deal of help in dealing with the problems of vegetable plant louse control. With this idea in mind the following circular has been prepared and it is hoped that it may in a measure, at least, meet the needs of our growers.

The Species of Plant Lice Concerned

Ninety-four species of plant lice are recognized as affecting various plants within the limits of the State of New Jersey. Of this number 12 are known as enemies of vegetable crops and of the vegetable infesting forms 6 or 7 are known to be seriously and at times severely injurious.

*Prepared February 26, 1919, by Thos. J. Headlee, Ph. D., Entomologist, New Jersey Agricultural Experiment Station.

Pink and Green Aphis of the Potato

(*Macrosiphum solanifolii* Ashm.)

The pink and green aphid of the potato passes the winter as an egg on rose bushes and probably upon various weeds. While no records of the spring habits are available for New Jersey, in Maine it has been found commonly upon rose plants. The first generations occur on relatively non-economic plants and it is only as the season advances and winged forms are produced that the lice migrate into the potato and tomato fields.

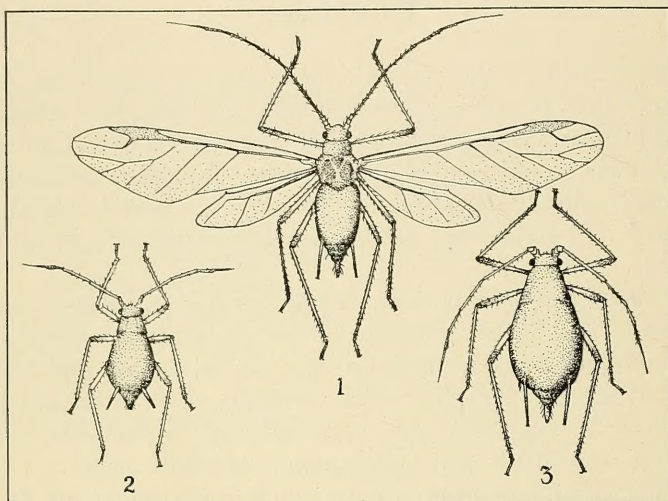


Fig. 1

PINK AND GREEN APHIS OF THE POTATO AND TOMATO

1—Adult winged female; 2—Immature female; 3—Adult wingless female

When they first arrive they are few in number and pass unnoticed by the grower. At this time here and there through the field will be found on the underside of a leaf a winged louse measuring about $\frac{1}{8}$ inch in length with several very small white young standing near her. At this time the plant has suffered no appreciable harm and, if prompt steps are taken to destroy the incipient infestation thus established, the crop is likely to escape all appreciable injury.

With favorable (cool) weather the lice reproduce rapidly. At this time all the lice are females and a single specimen can produce 50 young in 2 weeks. In 2 weeks after birth each of the young reaches maturity and begins bearing young on her own account.

It is entirely probable, then, that the infestation starts with a light infestation of winged migrants, which come in from roses and weeds on which the early generations were passed, and that for a period of several weeks there is rapid multiplication of the species without the grower being aware of anything unusual. When the lice have reached the point that there are many hundreds for each potato and tomato plant, the plants begin to look sickly and the grower finds to his amazement that they are covered with lice.

About the time the potato and tomato plants are seriously damaged natural enemies of the lice overtake them and those that do not develop wings and leave the fields are destroyed. Although little of a really definite character is known about their movements after leaving the tomato and potato fields, studies made in the State of Maine indicate that they may colonize a long list of weeds as well as members of the rose family.

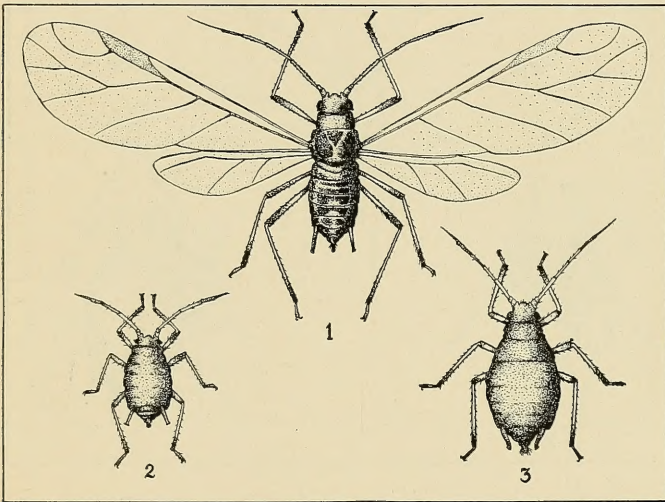


Fig. 2

THE GREEN PEACH APHIS

1—Adult winged female; 2—Immature female; 3—Adult wingless female

Green Peach Aphis

(*Myzus persicae* Sulz.)

The green peach aphid, alias the spinach aphid, passes the winter as a shining black egg upon the twigs and branches of peach, plum, nectarine, cherry and possibly other trees, and various weeds. The last possibility is mentioned because for the past several years this species has been very abundant upon vegetables and scarce upon the peach.

Hatching occurs in the early spring; the young aphids reach almost full growth by the time the blossoms open. When maturity is reached these lice are deep pink in color and begin to give birth to pale yellowish-green young that retain this color throughout their lives. These pale green specimens attack the foliage of the peach, causing it to curl and sometimes to fall.

The young produced by this second generation develop wings and distribute themselves over a large variety of vegetable crops. By the middle of June the lice have disappeared from the trees.

Generation follows generation throughout the summer. All are females and all bear living young. In the late fall (late October and early November) the winged forms leave the vegetables and return to the trees, and possibly certain weeds, where the true males and females are produced and the over-wintering eggs laid.

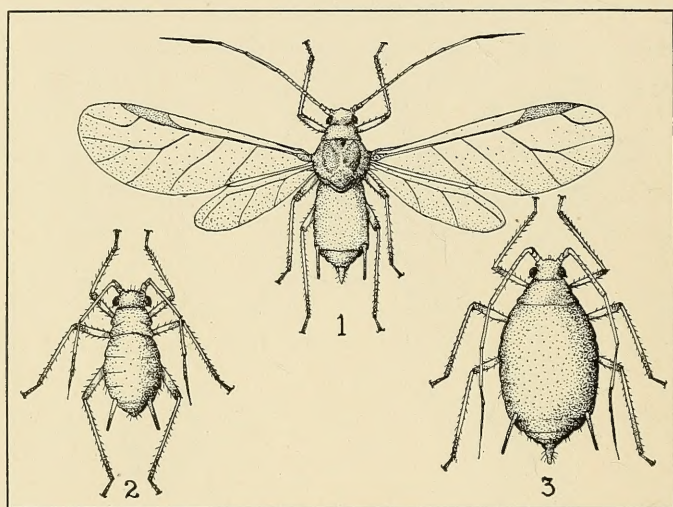


Fig. 3

THE GREEN PEA APHIS

1—Adult winged female; 2—Immature female; 3—Adult wingless female

Green Pea Louse

(*Macrosiphum pisi* Kalt)

The green pea louse passes the winter as an egg upon clovers, vetch and alfalfa. Hatching occurs in the early spring (late March in Central Illinois) and the early generations are passed thereon. Winged forms appear early and migrate to the peas when the plants are 6 to 8 inches high. All specimens throughout the spring, summer, and early fall are females and when mature capable of bearing living young.

Reproduction on the pea is rapid, and soon enough lice are present to sap the vitality of the plant, and the farmer finds that his peas are lousy and certain to give a greatly reduced crop if any at all.

By midsummer the pea crop is off and such of the lice as could not develop wings and escape, perish. The constant production of winged forms and their more or less constant movement lead to infestation of late peas when they are grown.

Throughout the season, breeding continues on clovers, and sometimes serious damage is done to that crop.

Late in the fall the winged forms, which may have been developed on vegetable crops, make their way back to clover and vetch, true males and females are produced and the over-wintering eggs laid.

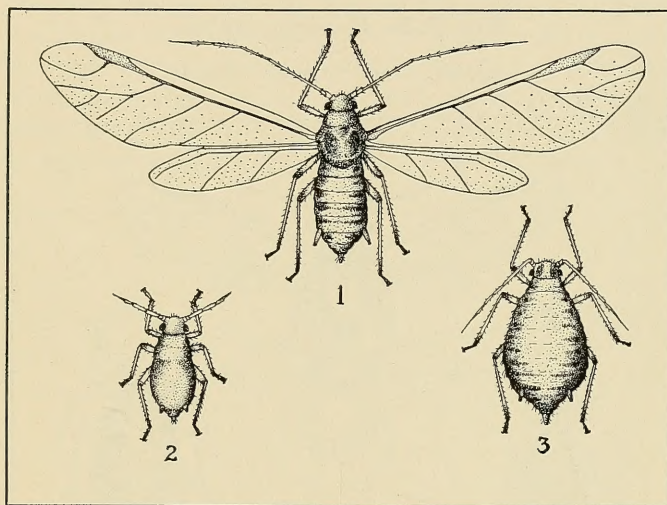


Fig. 4

CABBAGE APHIS

1—Adult winged female; 2—Immature female; 3—Adult wingless female

Bean Louse

(*Aphis rumicis* Linn.)

The species was taken on bean abundantly in the summer of 1916, but has not since been noted.

Cabbage Aphid

(*Aphis brassicae* Linn.)

The cabbage louse is a small green insect. Its body is apparently covered with a mealy powder.

The cabbage aphid passes the winter as an egg upon rape, turnip, brussels sprouts, kohlrabi and cabbage. Hatching occurs in late March and early April and generation of females follows generation until mid-fall when true males and females appear and the overwintering eggs are laid.

All summer broods produce a proportion of winged lice and the flight which occurs serves to distribute the lice throughout the plants of the cabbage family.

Beginning in spring the lice increase steadily in number until warm weather comes on. Then natural parasitic enemies develop even more rapidly and destroy vast numbers. When the cool weather of fall arrives the lice again increase in numbers until the cold weather stops further breeding.

The False Cabbage Aphid

(*Aphis pseudobrassicae* Davis)

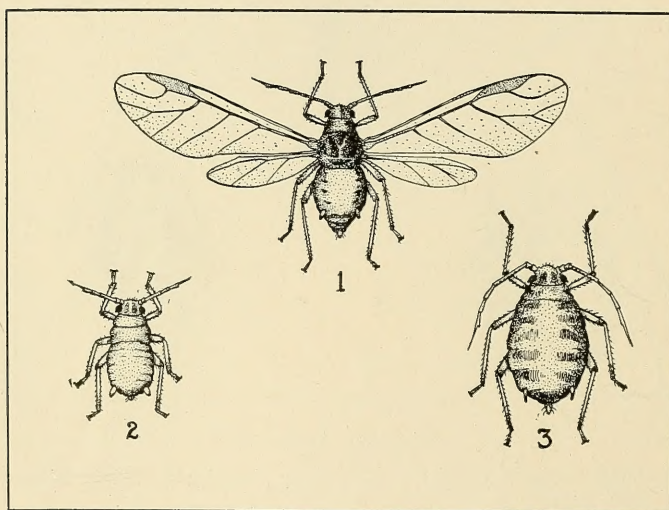


Fig. 5

THE FALSE CABBAGE APHIS

1—Adult winged female; 2—Immature female; 3—Adult wingless female

This, like the cabbage aphid, is covered with a powdery coating, but the coating is neither so heavy nor so complete as in the case of the true cabbage aphid.

It attacks a variety of plants within the cabbage family, being found on turnips, radishes, cabbage, kale, wild mustard, black mustard, rape, wild radish, 10 weeks stock and shepherd's purse.

The method of passing the winter has not as yet been determined, but it probably passes the cold season as an egg. The wingless lice are found in late April and continue generation after generation until cold weather. It usually reaches damaging numbers in the latter part of the season. It is perhaps the most rapid breeder among the plant lice.

The writer has observed this species in damaging numbers only on turnips. Large areas in Monmouth County have suffered severely from it.

Melon Aphis

(*Aphis gossypii* Glover)

The exact location and the stage in which this insect passes the winter is apparently not known, but it is probable that it winters on various weeds in the egg stage. At any rate, colonies of the melon plant louse are found on various weeds in early spring, and apparently from these colonies the winged forms (again all are females) fly into fields of melons, cucumbers and other cucurbits.

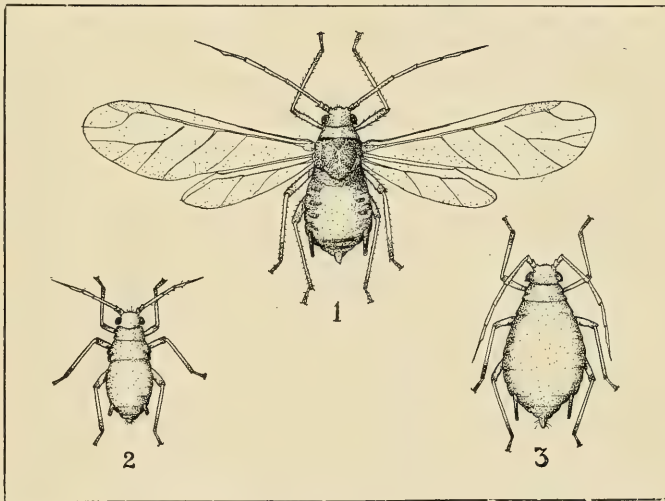


Fig. 6

MELON APHIS

1—Adult winged female; 2—Immature female; 3—Adult wingless female

Here again multiplication of numbers goes forward rapidly and soon the lice are sufficiently abundant to sap the plants and make them look sickly. A proportion of the summer broods is winged,

and migrations are constantly occurring. Colonies are found on a long list of plants, such as melons, cucumbers, okra, strawberry, purslane, clover, beans, beets, spinach, tomato, hops, pear, hydrangea, begonia, ground ivy, and morning glory, shepherd's purse, pepper grass, pigweed, dock, burdock, dandelion, lambsquarters, plantain, chick weed, button weed, yarrow and Jimson weed.

Under New Jersey conditions it seems that where there are large areas of favorite weed food plants adjacent to fields of melons, a heavy infestation may be quickly produced through migration from the weeds. This may follow a cutting of the weeds or their hardening under dry weather or through natural ripening processes.

Summary of Important Points in Life History

Plant lice affecting vegetables winter as eggs upon clovers, vetch, weeds and fruit trees. The cabbage aphid and probably the false cabbage aphid winter also upon the stalks and old leaves of cabbage cauliflower, etc.

Hatching occurs in early spring. All lice from spring hatching until fall are females and capable at maturity of bearing living young.

The first and second and in many cases later generations are produced on fruit trees, clovers, vetch and weeds. Infestation of the vegetable crop takes place by the migration of winged females from the early places of breeding.

Reproduction on the vegetable crop is rapid, and damage is done before the grower knows that anything is wrong.

Plant lice are most injurious in the early summer and the early fall because during the high temperatures of midsummer their vigor is impaired and their parasitic enemies destroy them.

Control of Vegetable Plant-Lice and the Prevention of the Injury

Which They Do

NATURAL CONTROL

The climate plays a very important part both directly and indirectly in combating aphid attacks. Without favorable conditions of weather they do not usually occur.

Explanation of Figure 7

1—Over-wintering egg; 2—Just hatched stem mother; 3—Matured stem mother; 4—Winged migrant on way to vegetable field; 5—Winged and wingless lice on various vegetables; 6—Winged migrant on way to plants where eggs are to be laid; 7—Male and female of the generation which produces the over-wintering egg. These are on the plants where the over-wintering eggs are to be laid

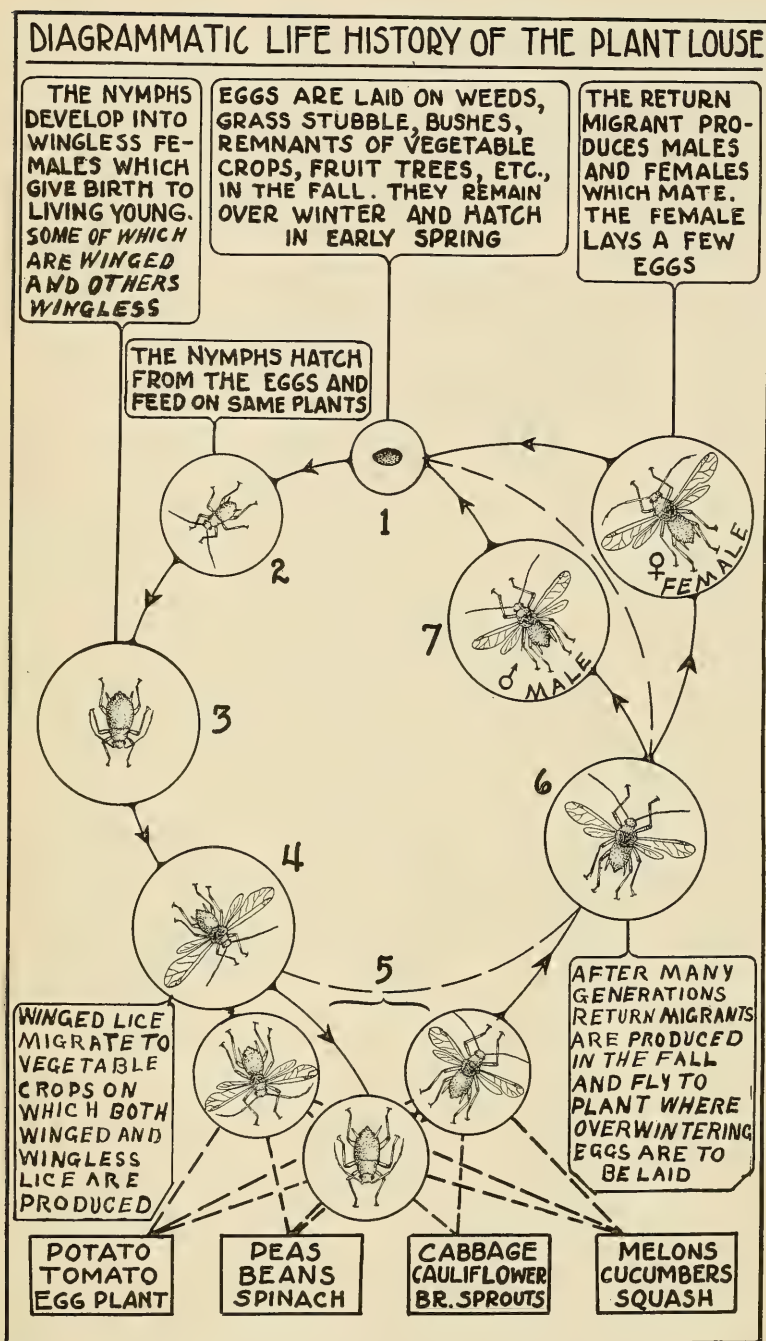


Fig. 7

DIAGRAMMATIC LIFE HISTORY OF THE PLANT LOUSE
(See bottom of page 10)

If, following the spring hatching, there should be sharp cold and freezing weather the starting colonies would be destroyed and the possibilities of an aphid outbreak prevented for the most if not the whole of that season.

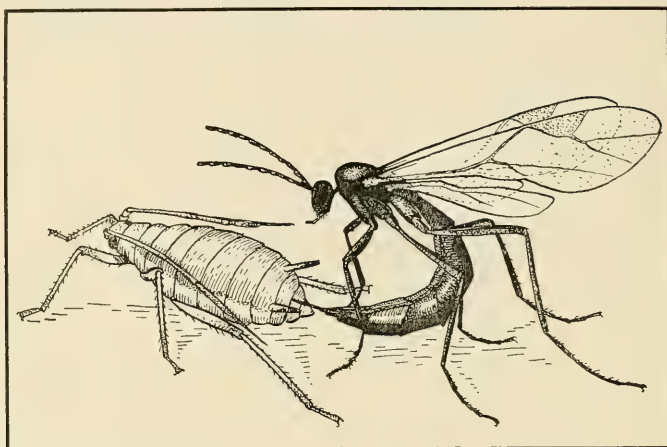


Fig. 8

ADULT PARASITE LAYING AN EGG IN THE LOUSE'S BODY
(After Webster)

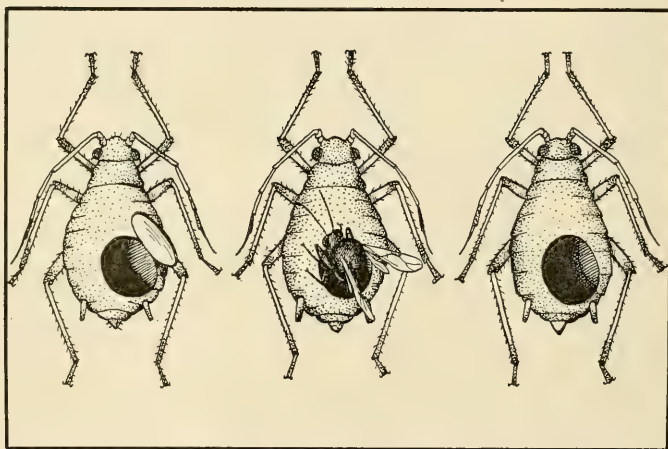


Fig. 9

THE PARASITE'S WORK

The parasite's development is completed within the plant louse body, killing the louse. The adult parasite escapes through a circular hole. (Adopted from Webster).

If the weather shows no sharp cold snaps after the lice hatch but remains cool throughout the spring and early summer, the lice are almost certain to be abundant and reach the proportions of a pest,

because while the lice can reproduce and increase in numbers, their small but most efficient natural enemies (very small four-winged bee-like insects, which sting their eggs into the louse's body and undergo their immature development inside the louse's body) cannot reproduce as rapidly as the lice. The only natural enemies that could be effective at such temperatures (the lady bird beetles) are rarely sufficiently abundant to eat the lice as fast as they can reproduce.

If at any time after the lice have become established upon a vegetable crop, there come hard dashing rains, the plants are likely to be washed nearly, if not completely, free from lice, and the outbreak stopped at that point.

CLEAN CULTURE

The fact that many of the vegetable-infesting plant lice produce their spring and early summer generations upon weeds, indicates that the practice of keeping down weeds should be followed. The fact that the cabbage aphid over-winters as an egg upon the remains of the cabbage and related plants indicates that the remnants of the crop should be removed from the ground and destroyed.

On the other hand, the good results of clean culture may largely be annulled when one is so unfortunate as to live among neighbors who cannot be induced to take up the practice.

DIRECT ARTIFICIAL CONTROL

The method of direct artificial control depends on the growth-habit and stage of growth of the crop infested, the size of the area concerned and whether grown in the open or under glass. For the sake of definiteness, the writer will discuss the treatment of lice on each important kind of vegetable crop with which he has had experience or concerning which he has been able to obtain reliable data from others.

On the Nightshade Family

Members of the nightshade family—potatoes, tomatoes, and egg-plant have an erect growth habit until they approach maturity when they in some cases become recumbent. The solution of the louse problem on this type of plant involves: (1) discovering the lice shortly after they arrive and before they have had time to injure the crop; (2) adoption and practice of measures that will effect their prompt destruction.

The first requisite can be fulfilled only by keeping a sharp watch of the field, examining at frequent intervals—say twice a week—the

under-sides of the foliage in different parts of the field. In this way the writer believes the infestation will be discovered before the plants assume a recumbent habit and therefore while effective spraying of them is still practicable. Colonization of the plants will be indicated not by the presence of an occasional winged plant louse on the foliage (they may be merely passing migrants of a species never using the plants of the nightshade family for food), but by the finding of winged lice each with a few tiny greenish-white young about her.

When the presence of lice indicates that spraying is necessary, (1) kerosene emulsion, (2) whale-oil soap, or (3) 40 per cent. nicotine, soap and water, may be employed. The first is cheap but difficult to make, and the margin between the strengths to kill the lice and to damage the plants is relatively narrow. The second is easy to prepare but the probable margin of safety is small. The third is more expensive but is easy to prepare, and the margin of safety between amount necessary to kill the louse and that dangerous to the plant is wide.

The writer for the present feels justified in recommending nicotine, soap and water as the best combination for this work. He recommends one part of 40 per cent nicotine to 500 parts of water to which soap is added at the rate of from 2 to 4 or 5 pounds to 50 gallons. The greater strength of soap is recommended when the water is not soft. Whale-oil soap is perhaps preferable to that used for laundry purposes, although any brand of the latter free from resinous matter will be found pretty satisfactory.

Having secured the material the means of applying is the next problem. When the crops are field-grown on a large scale, a power sprayer is a necessity. In small garden plots a knapsack sprayer or even a compressed air cylinder may be used with satisfactory results because the lack of pressure can be made up for by the care with which the infested plants are covered. In field spraying the most practicable machine the writer has seen is a regular potato spraying machine furnished with an engine-driven pump, which maintains constantly while at work a pressure of approximately 250 pounds to the square inch, and three properly set nozzles to each row. The side nozzles must be so set that one side of the entire plant from top to soil is covered by the cone made of discharging spray material from one nozzle and the other side similarly covered by the cone from the other nozzle, and the top is completely within the cone of spray material from the nozzle located above the row. In dealing with potatoes and tomatoes 100 gallons or more to the acre will probably be necessary. Saving spraying material by reducing the application is bad practice, for the chances of killing a sufficient percentage of the lice are none too good even when the most careful work is done.

To get the pressure, deliver the liquid and cover the vines requires modification of even the engine-equipped sprayers. The number of rows usually covered must be reduced. The holes in the nozzle disks must be reamed out and the side, and possibly the center nozzles, may have to be reset.

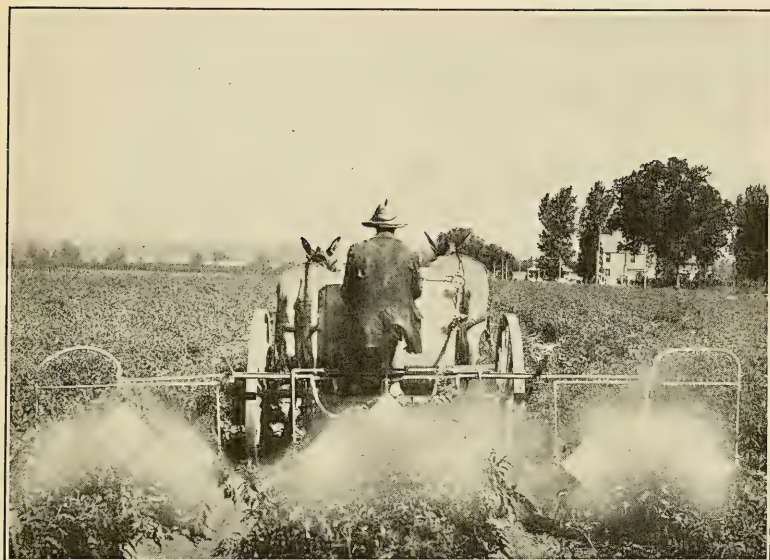


Fig. 10

FIELD SPRAYER IN OPERATION

To work out the modifications necessary, the following plan may be followed: (1) fill the tank with water, start the engine, with access to nozzles cut off, set the pressure valve at 250 pounds as indicated by the gauge, and then open the nozzles and spray a short round; (2) if the pressure does not keep up to 250, cut off one or more of the units for the outer rows until the pressure holds 250 pounds; (3) then spray a measured fraction of an acre, determining exactly how much water is used; (4) if the amount of water delivered is less than 100 gallons per acre, slightly enlarge the delivering holes through the nozzle plates and repeat the trial spraying; (5) if the pressure is not maintained it may be necessary to cut off another row unit; if the pressure is right but the amount of water delivered is below par, the nozzle holes will have to be further enlarged, but if the pressure is low and the amount of water delivered insufficient, bring up the pressure first; (6) thus continue to manipulate pressure and delivery until you get 100 or more gallons per acre at a pressure of approximately 250 pounds, (7) adjust the overhead nozzle at

such a height above the plants that the cone of spray which it delivers completely envelopes the top of the plant; (8) adjust the side nozzles at such a distance from the plant and such a height above the ground that the side of plant facing the nozzle will be from top to soil completely enveloped by the cone of spray delivered from it.

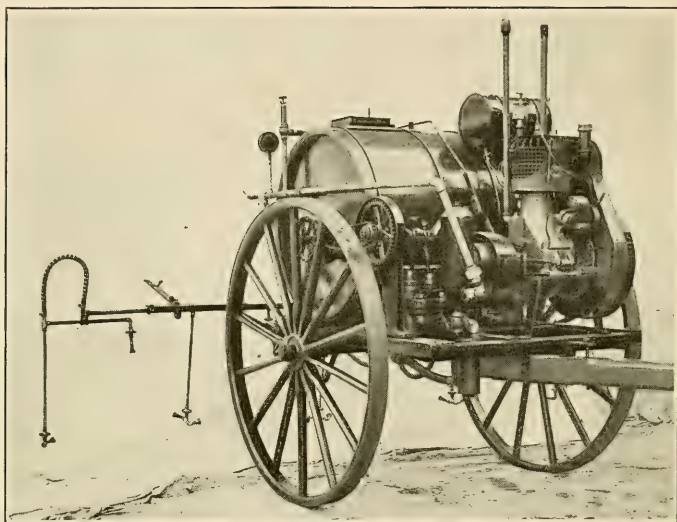


Fig. 11

ENGINE-DRIVEN POTATO SPRAYER SHOWING DETAILS OF NOZZLE ARRANGEMENT, ETC.

When members of the nightshade family are grown under glass, either in cold-frames or greenhouses, and become infested with lice, they can best be protected by fumigation with nicotine or hydrocyanic acid gas. The former is probably the most practicable except under greenhouse conditions, when a man experienced in the use of hydrocyanic acid gas is available. Tobacco paper, such as "nico fume," may be purchased from dealers in florists' supplies and used. While the amount to use will be marked on the package, the grower may find it necessary to experiment until he finds the dose that will destroy his lice, because the tightness of every enclosure differs from all others.

In dealing with the lice problem in low cold-frames where the burning of papers makes too much fire, 40 per cent nicotine may be evaporated over a small alcohol lamp. In such cases the strength of charge best suited will have to be determined by experiment. Start trials with strength recommended on the package. The best results

are likely to follow the use of a vaporizer under every, or at most, every other sash and the application of gas with a gentle or no wind during cloudy weather or in the late evening, for an exposure of 45 minutes.

On Peas and Beans

In New Jersey, peas suffer severely nearly every year and beans are occasionally infested. The writer has had so little experience in treating either of these crops that he hesitates even to attempt to offer any help. Where either crop is grown broadcast the control of aphids, except on very small plots, would appear to be impracticable.

Where planted in rows and before the recumbent habit makes its appearance, treatment by means of a spraying device, such as that recommended for potatoes and tomatoes should destroy the lice. It is very probable that the initial lice infestation appears before the recumbent habit develops.



Fig. 12

ENGINE-DRIVEN POTATO SPRAYER ADAPTED TO SPINACH

On Beets and Spinach

The louse problem on beets and spinach, particularly the latter, is one of the most difficult with which the writer has come in contact. The field beet problem may be met as hereafter described for turnips.

The field spinach problem must be met by spraying, the active agent being nicotine. At Norfolk, Virginia, a sprayer on the same order as an engine-driven potato sprayer, with several nozzles has been successfully used.

Lice on spinach grown under glass, in cold frames or green-houses yield to nicotine applications as set forth in treatment of tomatoes.

On the Cabbage Family

The problem of controlling plant lice on cabbage, cauliflower, turnips and other crops of the cabbage family is much complicated by the different growth habits of the various kinds of crops.

Lice on cabbage, if discovered promptly on their arrival, are easily controlled. On a garden scale the infestation may be destroyed by wetting them well with nicotine, soap and water applied with a knapsack or compressed air sprayer. On a field scale an engine-driven sprayer, modified as recommended for potato, may be used. In some cases the infested leaves may lie low enough to require the use of a lifting apparatus, such as recommended for turnips. Cabbages in cold frames are sometimes seriously infested with lice. Under these circumstances recourse should be had to tobacco smoke as outlined for tomatoes under glass.

If lice on cauliflower are destroyed when they first appear, the methods outlined for cabbage may be successfully employed, but if nothing is done against them until the plants have grown bushy control will prove difficult if not impracticable.

In dealing with the problem on turnips it will be necessary to utilize a lifting apparatus in connection with an engine-driven potato sprayer. This lifting device is made on half-inch iron rods shaped and attached to the sprayer as shown in figure 13.

Turnips grown in gardens may be treated with a knapsack or compressed air sprayer. In using either type of sprayer for this purpose a one-quarter or a half-inch gas pipe extension rod should be employed. This can be made by any plumber by cutting off a piece of half-inch gas pipe sufficiently long to reach from the hand to the ground and also in addition to allow for turning 2 to 2½ inches of the lower end at right angles to the main piece. The end of this turned up portion should be threaded for the attachment of the nozzle. With this sort of extension rod the spray may be delivered against the under-sides of the leaves where the lice feed and reproduce.

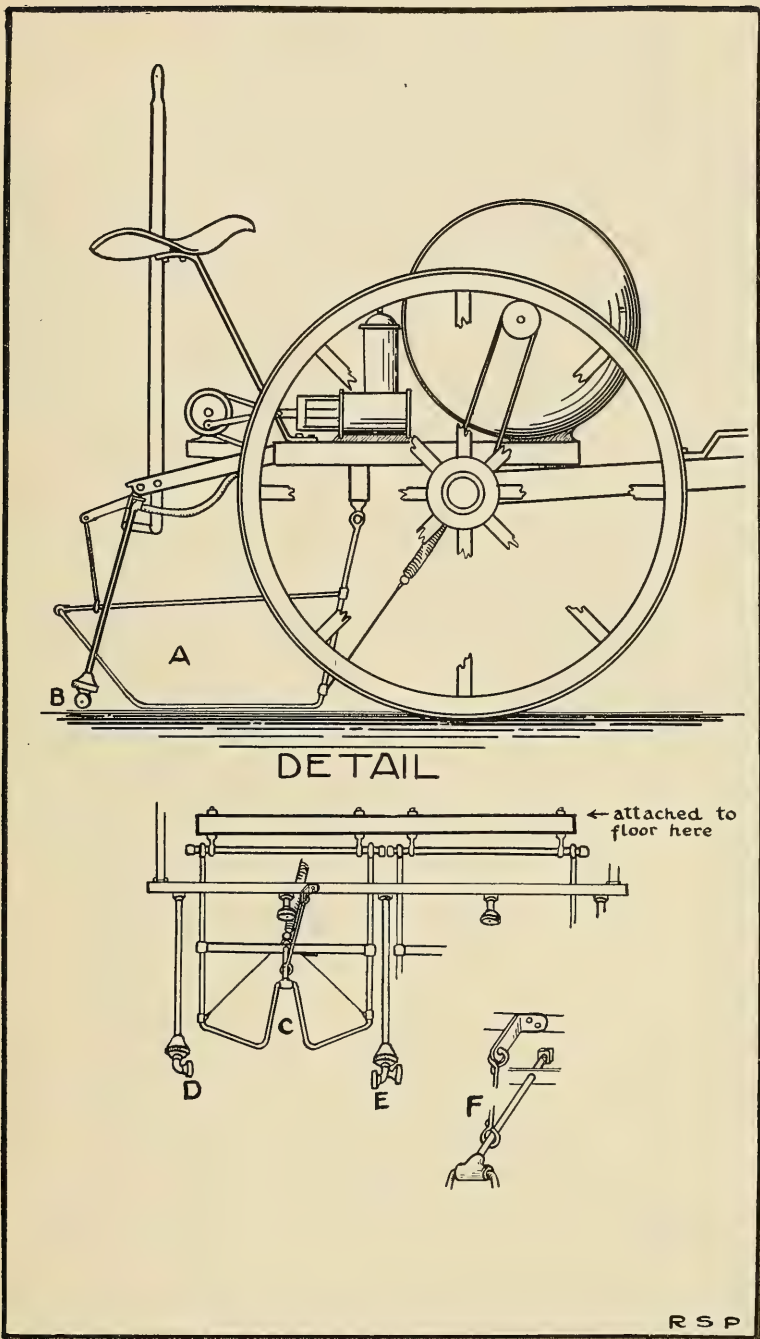


Fig. 13

A LIFTING DEVICE ATTACHED TO A POTATO SPRAYER

- A. Side-view of lifter. B. Soil. C. Space through which plants pass. D. and E. Nozzles. F. Arrangement for lifting the lifter at end of row when machine is turning

On the Cucurbs

The problem of lice control on melons and cucumbers appears to differ from that on most other vegetable crops in that not only may the infestation be initiated early while the plants are yet small, when it may be destroyed by the use of a good orchard sprayer, but after the vines are well grown they may become heavily and dangerously infested by lice that migrate from surrounding weed fields that are cut or have become too hard for further use. The last type of infestation should be met by turning the vines over ahead of the operation and thoroughly wetting the lice with a good orchard sprayer and then returning the vines to the normal position. Of course, after the vines have interlaced, treatment by anything other than a knapsack or other hand sprayer is out of the question.

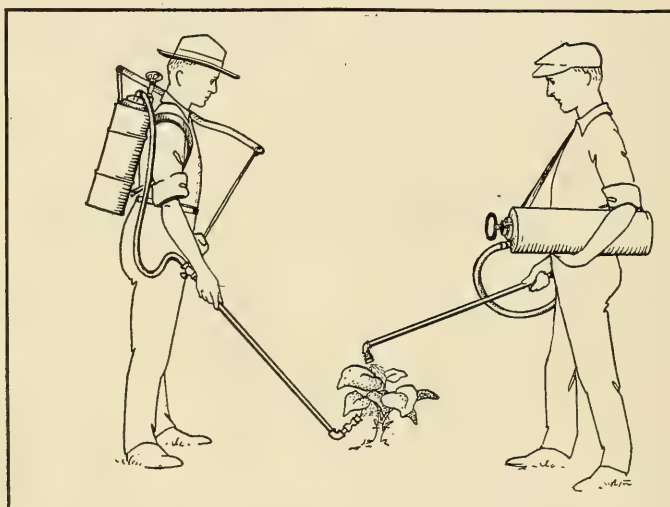


Fig. 14

KNAPSACK AND COMPRESSED AIR SPRAYERS WITH PROPER SORT
OF EXTENSION ROD

On Lettuce

Lettuce grown in cold frames or in greenhouses may become seriously infested. The lice may be destroyed in this case by use of tobacco fumes as recommended for tomatoes. For lettuce in the field, which becomes infested, there is not at present any remedy worked out.

Summary of Measures of Control

1. The weather, affecting the lice directly through freezing and indirectly through limiting the work of natural enemies, determines largely whether there shall or shall not be a vegetable plant louse outbreak.

2. Because of the fact that the plant lice winter upon plants other than vegetables or upon the useless remains of vegetable crops, clean culture—keeping down weeds and destroying the useless remnants of vegetable crops—is an important measure of control, provided that its general adoption can be secured.

3. Because of the inconspicuous nature of the work of vegetable plant lice—the effects of their work not appearing until the damage has largely been completed—it is highly important that the beginning of the infestation be detected by the growers.

4. Under garden or field conditions promptly apply a mixture of 40 per cent. nicotine (1 part), water (500 parts), and soap (2 lbs. if water is soft or 4 to 5 lbs. if water is hard, to 50 gallons) as soon as infestation appears.

5. For garden crops use a knapsack or compressed-air sprayer equipped with extension rod specified on page 18 and illustrated in figure 14. For field crops use a modified engine-driven potato sprayer, maintaining a pressure of 250 pounds to the square inch and delivering at least 100 gallons per acre. When plants stand upright the modification is merely a matter of adjusting the nozzles in such a way that the plant is completely covered and the lice well wetted. When plants have a pronounced drooping leaf habit, as in turnips, attach a lifting device to the sprayer.

6. For cold-frame or greenhouse vegetable crops the lice may be destroyed by use of tobacco smoke of strength corresponding to the tightness or looseness of the enclosure. In a few of the vegetable crops grown in greenhouses, such as cucumbers and tomatoes, hydrocyanic gas is successfully employed.

7. In cantaloupes, when the infestation appears suddenly after the vines are well grown, apply the nicotine, soap and water mixture with a good orchard sprayer after the vines have been turned over in such a way as to expose the plants. Use a good orchard sprayer when the infestation appears early.

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